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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/594,739

08/22/2007

Tadashi Terasaki

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EXAMINER

HAN, JONATHAN

ART UNIT

PAPER NUMBER

2818

NOTIFICATION DATE

DELIVERY MODE

12/03/2009

ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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Office Action Summary	Application No. 10/594,739	Applicant(s) TERASAKI ET AL.	
	Examiner JONATHAN HAN	Art Unit 2818	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 14 August 2009.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-8 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-8 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 29 September 2006 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date <u>11/19/2009</u> . | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

This Office Action is responsive to the Applicant's communication filed 08/14/2009. In virtue of this communication, claims 1-8 are pending in the instant application.

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

3. Claims 1-3 rejected under 35 U.S.C. 103(a) as being unpatentable over Yamada et al (U.S. Publication No. 2005/0003670 A1; hereinafter referred to as "Yamada") in view of Cheng et al. (U.S. Patent No. 6,649,538 B1; hereinafter referred to as Cheng) and Klein et al. (U.S. Patent No. 6,046,088; hereinafter referred to as "Klein").

With respect to claim 1, Yamada discloses a producing method of a

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semiconductor device, comprising: the silicon oxide film formed after a surface of a silicon substrate is etched (see Page 3, Paragraph [0049]; start of subsequent etching processes), and film thinning a silicon oxide film by heating (see Page 3, Paragraph [0050]-[0051]).

Yamada fails to disclose a surface of a silicon substrate is etched by chemical liquid, one of thermal oxidizing by heating the thinned silicon oxide film to oxidize the silicon oxide film by gas including at least oxygen, and plasma oxidizing the thinned silicon oxide film by plasma discharged gas including at least oxygen.

Klein teaches a substrate etched by chemical liquid (see Klein Column 4, lines 9-11; see Figure 3 and Figure 5, substrate is etched and silicon oxide [17] is subsequently formed) but fails to teach one of thermal oxidizing by heating the thinned silicon oxide film to oxidize the silicon oxide film by gas including at least oxygen, and plasma oxidizing the thinned silicon oxide film by plasma discharged gas including at least oxygen.

Cheng teaches one of thermal oxidizing by heating the thinned silicon oxide film to oxidize the silicon oxide film by gas including at least oxygen, and plasma oxidizing the thinned silicon oxide film by plasma discharged gas including at least oxygen (see Column 5, lines 30-39).

It would have been obvious to one of ordinary skill in the art at the time of invention to perform the etching of the trench as disclosed by Yamada using a wet etch as taught by Klein and further to perform the plasma treatment process as taught by Cheng after etching by chemical liquid and heating the substrate as taught by the

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combination of Yamada and Klein in order prepare the surface of the layer for plasma nitriding of the oxide layer and further densify the oxide and provide more effective nitrogen penetration. (see Cheng, Column 5, lines 30-39, 50-58).

With respect to claim 2, the combination of Yamada, Klein and Cheng discloses all material as stated in claim 1 and further discloses the silicon oxide film formed after the etching is carried out is processed at 800°C or higher (see Page 3, Yamada Paragraph [0050]).

With respect to claim 3, the combination of Yamada, Klein and Cheng discloses all material as stated in claim 2 and further discloses wherein in the film thinning step, the silicon oxide film formed after the etching is carried out is processed at 800°C to 1000°C (see Page 3, Yamada Paragraph [0050]).

4. Claims 4-7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yamada et al (U.S. Publication No. 2005/0003670 A1; hereinafter referred to as "Yamada") in view of Cheng et al. (U.S. Patent No. 6,649,538 B1; hereinafter referred to as Cheng) and Klein et al. (U.S. Patent No. 6,046,088; hereinafter referred to as "Klein") as applied to claims 1-3 above, and further in view of Tokai et al (U.S. Patent No. 6,566,199 B2; hereinafter referred to Tokai).

With respect to claim 4, the combination of Yamada, Klein and Cheng discloses all material as stated in claim 1-3 and further discloses the silicon oxide formed after the etching is carried out is processed within a nitrogen atmosphere (see Cheng, Column 6, lines 41-52) but fails to disclose in the film thinning, the silicon oxide film formed after the etching is carried out is processed under a reduced pressure.

Tokai teaches in the film thinning, the silicon oxide film formed after the etching is carried out is processed under a reduced pressure (see Tokai; Column 2, lines 43-57 same RTO under reduced pressure).

It would have been obvious to one of ordinary skill in the art at the time of invention to implement the process as taught by Tokai of reducing the pressure in the chamber while heating the substrate as taught by the combination of Yamada, Klein and Cheng in order to promote better reactivity of film formation (see Tokai; Column 2, lines 39-42)

With respect to claim 5, the combination of Yamada, Cheng, Klein and Tokai discloses all material as stated in claim 4 and further discloses wherein the reduced pressure is 266 Pa to 2660 Pa (see Tokai Column 3, lines 63-66).

With respect to claim 6, the combination of Yamada, Cheng, Klein and Tokai discloses all material as stated in claim 4 and further discloses the silicon oxide film formed after the etching is carried out is processed by nitrogen (see Cheng; Column 6, lines 41-52).

With respect to claim 7, the combination of Yamada, Cheng, Klein and Tokai discloses all material as stated in claim 6 and further discloses the silicon oxide film formed after the etching is carried out is processed for 5 seconds to 60 seconds (see Cheng; Column 5, lines 13-14).

5. Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Yamada et al (U.S. Publication No. 2005/0003670 A1; hereinafter referred to as "Yamada") in view of Cheng et al. (U.S. Patent No. 6,649,538 B1; hereinafter referred to as Cheng)

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and Klein et al. (U.S. Patent No. 6,046,088; hereinafter referred to as "Klein") as applied to claims 1-3 above, and further in view of Yu et al (U.S. Patent No. 6,362,085 B1; hereinafter referred to as "Yu").

With respect to claim 8, the combination of Yamada and Cheng discloses all material as stated in claims 1-3 and further discloses plasma nitriding the silicon oxide film by plasma discharged gas including at least nitrogen to form a silicon oxynitride film (see Cheng; Column 4, lines 56-59; nitriding SiO_2 produces silicon oxynitride).

Cheng fails to disclose wherein a dose amount of nitrogen of the silicon oxynitride film is made to be 1×10^{15} [atoms/cm²] or higher by the plasma nitriding.

Yu teaches a dose amount of nitrogen of the silicon oxynitride film is made to be 1×10^{15} [atoms/cm²] or higher by the plasma nitriding (see Column 5, lines 30-37).

It would have been obvious to one of ordinary skill in the art at the time of invention to ion implant the nitrogen molecules at a dosage of amount as taught by Yu within the silicon oxynitride layer as disclosed by the combination of Yamada, Klein and Cheng in order to increase the dielectric constant of the oxide layer (see Yu Column 6, lines 21-27).

Response to Arguments

6. Applicant's arguments filed 08/14/2009 have been fully considered but they are not persuasive.

With respect to claims 1-3, Applicant states that Yamada fails to disclose that a silicon oxide film is formed after a surface of a silicon substrate is etched by chemical

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liquid and the oxide film is heated to thin the film. Examiner respectfully disagrees.

¶[0049]-[0051] of Yamada was disclosed by the examiner to identify the paragraph of which etching occurs to etch layers above the layers of the substrate to remove portions that are not required for masking, subsequently etching and heating the substrate below in the device isolation regions using those above films as a mask. Subsequently a silicon oxide is formed on the etched surface (as noted by the applicant). Furthermore, Klein shows an analogous process in which a trench is formed and etched away from the substrate with a silicon oxide formed thereon (see Figure 7, trenches formed in the substrate with [17] being a field oxide formed of silicon oxide).

With respect to claims 4-7, Applicant's arguments fail to comply with 37 CFR 1.111(b) because they amount to a general allegation that the claims define a patentable invention without specifically pointing out how the language of the claims patentably distinguishes them from the references. See rejection above of claim 4, regarding application of the combination of Yamada, Cheng, Klein and Tokai.

Citation of Pertinent Art

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

- Fujimaki (U.S. Publication No. 2003/0203582 A1) discloses heat treatment in a nitrogen atmosphere.

- Igeta et al (U.S. Publication No. 2003/0170945 A1) discloses nitriding an oxygen insulation film using high-frequency plasma.

- Ballantine et al. (U.S. Patent No. 6,444,592 B1) discloses forming a silicon oxide film being produced using Rapid Thermal Oxidation.

Conclusion

7. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

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Any inquiry concerning this communication or earlier communications from the examiner should be directed to JONATHAN HAN whose telephone number is (571)270-7546. The examiner can normally be reached on Monday through Friday 8:30 AM - 6 PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Steven Loke can be reached on (571)272-1657. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/JONATHAN HAN/
Examiner, Art Unit 2818

/STEVEN LOKE/
Supervisory Patent Examiner, Art Unit 2818